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U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES

REPORT

ON

OLIN LAKE

LAGRANGE COUNTY

INDIANA

EPA REGION V

WORKING PAPER No. 338

CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON

and

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

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REPORT

ON

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WITH THE COOPERATION OF THE

INDIANA STATE BOARD OF HEALTH

AND THE

INDIANA NATIONAL GUARD

MARCH, 1976

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F O R E W O R D

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning {§303(e)}, water quality criteria/standards review {§303(c)}, clean lakes {§314(a,b)}, and water quality monitoring {§106 and §305(b)} activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Indiana State Board of Health for professional involvement, to the Indiana National Guard for conducting the tributary sampling phase of the Survey, and to those Indiana wastewater treatment plant operators who provided effluent samples and flow data.

The staff of the Division of Water Pollution Control, Indiana State Board of Health, provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

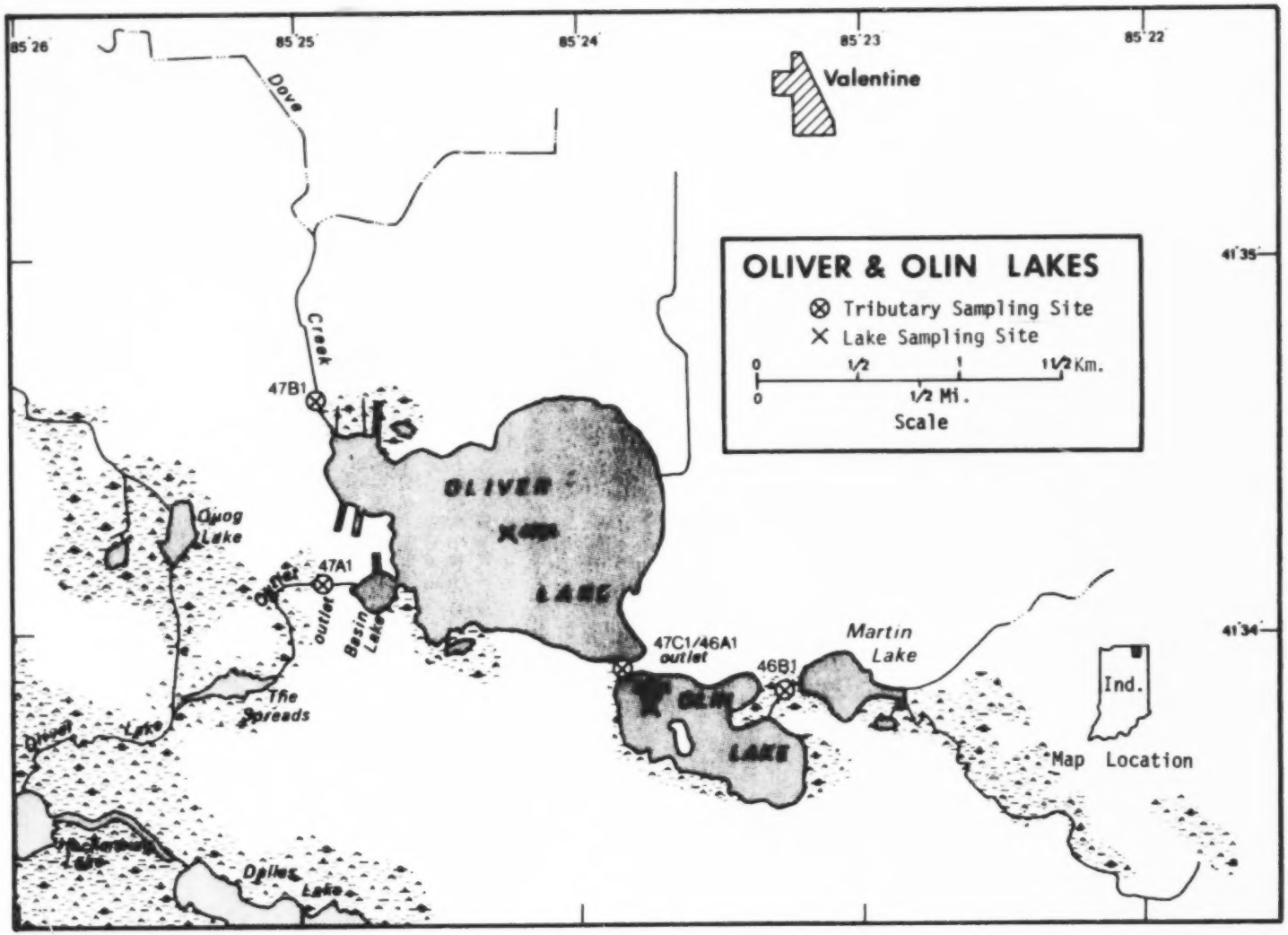
Major General Alfred F. Ahner, Adjutant General of Indiana, and Project Officers Lt. Colonel Charles B. Roberts (Retired) and Colonel Robert L. Sharp, who directed the volunteer efforts of the Indiana National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF INDIANA

LAKE NAME	COUNTY
Bass	Starke
Cataract	Owen, Putnam
Crooked	Steuben
Dallas	LaGrange
Geist	Hamilton, Marion
Hamilton	Steuben
Hovey	Posey
James	Kosciusko
James	Steuben
Long	Steuben
Marsh	Steuben
Mississinewa	Grant, Miami, Wabash
Maxinkuckee	Marshall
Monroe	Brown, Monroe
Morse	Hamilton
Olin	LaGrange
Oliver	LaGrange
Pigeon	Steuben
Sylvan	Noble
Tippecanoe	Kosciusko
Versailles	Ripley
Wawassee	Kosciusko
Webster	Kosciusko
Westler	LaGrange
Whitewater	Union
Winona	Kosciusko
Witmer	LaGrange


OLIVER & OLIN LAKES
Tributary Sampling Site
Lake Sampling Site
0 1/2 1 1 1/2 Km.
0 1/2 Mi.
Scale
Valentine
Ind.
Map Location
85°26'
85°25'
85°24'
85°23'
85°22'
41°35'
41°34'
Dove
Creek
47B1
Quog Lake
47A1
outlet
Basin Lake
OLIVER LAKE
47C1/46A1
outlet
46B1
Martin Lake
OLIN LAKE
The Spreads
Oliver Lake
Dallas Lake

OLIN LAKE

STORET NO. 1846

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Olin Lake is mesotrophic. It ranked sixth in overall trophic quality when the 27 Indiana lakes sampled in 1973 were compared using a combination of six parameters*. One lake had less and one had the same median total phosphorus, none had less but two had the same median dissolved phosphorus, 20 had less median inorganic nitrogen, two had less mean chlorophyll a, and five had greater mean Secchi disc transparency. Near-depletion of dissolved oxygen with depth occurred in August and October.

Survey limnologists did not observe surface concentrations of algae but reported emergent and submerged macrophytes in the shallow areas in August and October.

B. Rate-Limiting Nutrient:

The algal assay results indicate that Olin Lake was phosphorus limited at the time the sample was collected (05/04/73). The lake data indicate phosphorus limitation at the other sampling times as well.

C. Nutrient Controllability:

1. Point sources--No known point sources impacted Olin Lake during the sampling year.

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* See Appendix A.

The present phosphorus loading of 0.81 $g/m^2/yr$ is about 1.3 times that proposed by Vollenweider (Vollenweider and Dillon, 1974) as a eutrophic loading (see page 11). For this reason, and because the lake is phosphorus limited, all phosphorus inputs should be minimized to the greatest practicable degree to slow the aging of this water body.

2. Non-point sources--All of the phosphorus input to Olin Lake during the sampling year was contributed by non-point sources. The Martin Lake outlet contributed 85.3%, and the ungaged tributaries were estimated to have contributed 13.2% of the total load.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS†

A. Lake Morphometry††:

1. Surface area: 0.42 kilometers^2.
2. Mean depth: 11.7 meters.
3. Maximum depth: 25.0 meters.
4. Volume: 4.914×10^6 m^3.
5. Mean hydraulic retention time: 1.1 years.

B. Tributary and Outlet:
(See Appendix C for flow data)

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
Martin Lake outlet	12.7	0.12
Minor tributaries & immediate drainage -	1.9	0.02
Totals	14.6	0.14

2. Outlet -

Olin Lake outlet	15.0**	0.14

C. Precipitation***:

1. Year of sampling: 111.6 centimeters.
2. Mean annual: 91.3 centimeters.

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† Table of metric conversions--Appendix B.
†† Winters, 1975.
* For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
** Includes area of lake.
*** See Working Paper No. 175.

III. LAKE WATER QUALITY SUMMARY

Olin Lake was sampled three times during the open-water season of 1973 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from a number of depths at one station on the lake (see map, page v). During each visit, a single depth-integrated (4.6 m to surface) sample was collected for phytoplankton identification and enumeration, and a similar sample was taken for chlorophyll a analysis. During the first visit, a single 18.9-liter depth-integrated sample was collected for algal assays. The maximum depth sampled was 17.7 meters.

The sampling results are presented in full in Appendix D and are summarized in the following table.

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR OLIN LAKE
STORET CODE 1846

PARAMETER	1ST SAMPLING (5/ 4/73) 1 SITES RANGE	MEAN	MEDIAN	2ND SAMPLING (8/ 6/73) 1 SITES RANGE	MEAN	MEDIAN	3RD SAMPLING (10/11/73) 1 SITES RANGE	MEAN	MEDIAN
TEMP (C)	7.8 - 12.3	9.9	9.8	6.0 - 25.4	15.5	15.2	6.1 - 19.9	12.2	9.9
DISS OXY (MG/L)	8.1 - 10.8	9.6	9.4	0.4 - 9.0	4.5	4.2	0.1 - 9.6	4.8	4.8
CNDCTVY (MCROMO)	480. - 520.	493.	490.	325. - 440.	384.	389.	327. - 390.	357.	367.
PH (STAND UNITS)	8.1 - 8.4	8.3	8.4	7.5 - 8.4	7.9	7.9	7.3 - 8.5	7.9	7.9
TOT ALK (MG/L)	180. - 232.	194.	190.	179. - 230.	203.	204.	156. - 226.	183.	181.
TOT P (MG/L)	0.007 - 0.015	0.011	0.011	0.009 - 0.015	0.011	0.011	0.011 - 0.026	0.015	0.013
ORTHO P (MG/L)	0.002 - 0.002	0.002	0.002	0.002 - 0.009	0.004	0.003	0.011 - 0.026	0.014	0.013
NO2+NO3 (MG/L)	1.400 - 1.510	1.447	1.430	0.790 - 1.630	1.267	1.245	0.050 - 1.450	0.941	0.920
AMMONIA (MG/L)	0.030 - 0.100	0.053	0.040	0.040 - 0.370	0.118	0.060	0.040 - 0.810	0.169	0.050
KJEL N (MG/L)	0.300 - 0.500	0.371	0.400	0.400 - 1.000	0.617	0.550	0.500 - 1.600	0.700	0.600
INORG N (MG/L)	1.460 - 1.590	1.500	1.490	1.160 - 1.670	1.385	1.335	0.860 - 1.500	1.110	0.960
TOTAL N (MG/L)	1.700 - 2.010	1.819	1.820	1.670 - 2.230	1.883	1.850	1.400 - 2.050	1.641	1.550
CHLRPYL A (UG/L)	6.9 - 6.9	6.9	6.9	3.5 - 3.5	3.5	3.5	4.2 - 4.2	4.2	4.2
SECCHI (METERS)	2.6 - 2.6	2.6	2.6	1.4 - 1.4	1.4	1.4	3.4 - 3.4	3.4	3.4

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
05/04/73	1. *Fragilaria sp.*	904
	2. *Dinobryon sp.*	572
	3. *Anabaena sp.*	512
	4. *Asterionella sp.*	301
	5. *Melosira sp.*	256
	Other genera	859
	Total	3,404
08/06/73	1. *Cyclotella sp.*	757
	2. *Melosira sp.*	512
	3. Flagellates	220
	4. *Aphanizomenon sp.*	195
	5. *Microcystis sp.*	146
	Other genera	244
	Total	2,074
10/11/73	1. Coccoid cells	227
	2. Flagellates	178
	3. *Coelosphaerium sp.*	69
	4. *Aphanizomenon sp.*	59
	5. *Cryptomonas sp.*	39
	Other genera	60
	Total	632

2. Chlorophyll *a* -

Sampling Date	Station Number	Chlorophyll *a* (μg/l)
05/04/73	1	6.9
08/06/73	1	3.5
10/11/73	1	4.2

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.010	1.625	0.1
0.050 P	0.060	1.625	13.1
0.050 P + 1.0 N	0.060	2.625	12.2
1.0 N	0.010	2.625	0.1

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity of Olin Lake was low at the time the sample was collected. The significant increase in yield with the addition of orthophosphorus alone indicates phosphorus limitation. Note that the addition of only nitrogen produced no such increase.

The lake data also indicate limitation by phosphorus; at all sampling times, the mean inorganic nitrogen/orthophosphorus ratios were 79/1 or greater.

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the Indiana National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff months of February and March when two samples were collected. Sampling was begun in June, 1973, and was completed in May, 1974.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Indiana District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*.

Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the nutrient loads, in $kg/km^2/year$, at station B-1 and multiplying by the ZZ area in km^2.

No known point sources impacted Olin Lake during the sampling year.

* See Working Paper No. 175.

A. Waste Sources:

1. Known municipal - None

2. Known industrial - None

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/ yr	% of total
a. Tributaries (non-point load) -		
Martin Lake outlet	290	85.3
b. Minor tributaries & immediate drainage (non-point load) -	45	13.2
c. Known municipal STP's - None	-	-
d. Septic tanks - None	-	-
e. Known industrial - None	-	-
f. Direct precipitation* -	5	1.5
Total	340	100.0

2. Outputs -

Olin Lake outlet 70

3. Net annual P accumulation - 270 kg.

* See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (non-point load) -		
Martin Lake outlet	12,260	84.3
b. Minor tributaries & immediate drainage (non-point load) -	1,835	12.6
c. Known municipal STP's - None	-	-
d. Septic tanks - None	-	-
e. Known industrial - None	-	-
f. Direct precipitation* -	455	3.1
Total	14,550	100.0

2. Outputs -

Olin Lake outlet 9,000

3. Net annual N accumulation - 5,550 kg.

D. Mean Annual Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km^2/yr	kg N/km^2/yr
Martin Lake outlet	23	965

* See Working Paper No. 175.

E. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m^2/yr	0.81	0.64	34.6	13.2
Vollenweider phosphorus loadings ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Olin Lake:				
"Dangerous" (eutrophic loading)			0.62	
"Permissible" (oligotrophic loading)			0.31	

V. LITERATURE REVIEWED

Vollenweider, R. A., and P. J. Dillon, 1974. The application of the phosphorus loading concept to eutrophication research. Natl. Res. Council of Canada Publ. No. 13690, Canada Centre for Inland Waters, Burlington, Ontario.

Winters, John, 1975. Personal communication (lake morphometry). IN Div. Water Poll. Contr., Indianapolis.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500- MEAN SEC	MEAN CHLORA	15- MIN DO	MEDIAN DISS ORTHO P
1805	CATARACT LAKE	0.055	1.660	466.667	10.744	15.000	0.013
1811	GEIST RESERVOIR	0.074	1.080	472.500	45.950	11.600	0.009
1817	JAMES LAKE	0.024	1.030	434.000	11.533	15.000	0.008
1827	MISSISSINEWA RESERVOIR	0.107	2.400	473.444	15.778	15.000	0.029
1828	MONROE RESERVOIR	0.025	0.325	438.623	6.947	15.000	0.007
1829	MORSE RESERVOIR	0.084	3.325	473.222	56.167	15.000	0.009
1836	WAWASEE LAKE	0.012	0.210	364.500	5.000	14.600	0.003
1837	WEBSTER LAKE	0.025	0.790	431.000	11.500	15.000	0.005
1839	WHITEWATER LAKE	0.084	1.620	470.167	33.083	15.000	0.012
1840	WINONA LAKE	0.035	1.250	444.667	11.211	15.000	0.011
1841	WESTLEY LAKE	0.035	0.860	427.125	10.712	15.000	0.013
1842	WITMER LAKE	0.035	0.900	440.333	11.917	15.000	0.011
1843	LAKE MAKINKUCKEE	0.020	0.220	480.400	5.483	15.000	0.003
1844	TIPPECANOE LAKE	0.019	0.195	391.500	6.050	15.000	0.005
1845	DALLAS LAKE	0.029	0.830	413.333	10.067	15.000	0.014
1846	OLIN LAKE	0.012	1.460	403.333	4.867	14.900	0.003
1847	OLIVER LAKE	0.009	0.920	392.000	3.767	14.800	0.004
1848	SYLVAN LAKE	0.170	0.130	469.833	47.480	14.800	0.017
1849	HOVEY LAKE	0.062	1.050	489.333	84.267	7.600	0.024
1850	VERSAILLES LAKE	0.139	1.090	482.000	25.078	14.500	0.019
1851	BASS LAKE	0.040	0.250	471.375	29.367	7.000	0.012
1852	CROOKED LAKE	0.019	0.120	410.111	5.578	15.000	0.005
1853	LAKE JAMES	0.016	0.190	352.444	4.856	15.000	0.005
1854	LONG LAKE	0.204	1.920	442.667	16.100	15.000	0.150
1855	PIGEON LAKE	0.058	1.945	442.667	11.980	15.000	0.015
1856	MARSH LAKE	0.043	0.270	451.333	34.467	15.000	0.055
1857	HAMILTON LAKE	0.033	0.720	413.167	17.450	15.000	0.018

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500- MEAN SEC	MEAN CHLORA	15- MIN DO	MEDIAN DISS ORTHO P	INDEX NO
1805	CATARACT LAKE	37 (9)	15 (4)	31 (8)	62 (16)	35 (0)	37 (9)	217
1811	GEIST RESERVOIR	27 (7)	35 (9)	15 (4)	12 (3)	92 (24)	62 (16)	243
1817	JAMES LAKE	73 (19)	42 (11)	58 (15)	50 (13)	35 (0)	65 (17)	323
1827	MISSISSINEWA RESERVOIR	12 (3)	4 (1)	8 (2)	38 (10)	35 (0)	8 (2)	105
1828	MONROE RESERVOIR	67 (17)	69 (18)	54 (14)	73 (19)	35 (0)	69 (18)	367
1829	MORSE RESERVOIR	23 (6)	0 (0)	12 (3)	4 (1)	35 (0)	58 (15)	132
1836	WAWASEE LAKE	94 (24)	85 (22)	96 (25)	88 (23)	85 (22)	98 (25)	546
1837	WEBSTER LAKE	67 (17)	62 (16)	62 (16)	54 (14)	35 (0)	81 (21)	361
1839	WHITEWATER LAKE	19 (5)	19 (5)	23 (6)	19 (5)	35 (0)	42 (11)	157
1840	WINONA LAKE	50 (12)	27 (7)	38 (10)	58 (15)	35 (0)	52 (13)	260
1841	WESTLER LAKE	50 (12)	54 (14)	65 (17)	65 (17)	35 (0)	37 (9)	306
1842	WITMER LAKE	50 (12)	50 (13)	50 (13)	42 (11)	35 (0)	52 (13)	279
1843	LAKE MAXINKUCKEE	77 (20)	81 (21)	85 (22)	85 (22)	35 (0)	98 (25)	461
1844	TIPPECANOE LAKE	85 (22)	88 (23)	92 (24)	77 (20)	35 (0)	85 (22)	462
1845	DALLAS LAKE	62 (16)	58 (15)	69 (18)	69 (18)	35 (0)	31 (8)	324
1846	OLIN LAKE	94 (24)	23 (6)	81 (21)	92 (24)	73 (19)	92 (24)	455
1847	OLIVER LAKE	100 (26)	46 (12)	88 (23)	100 (26)	79 (20)	88 (23)	501
1848	SYLVAN LAKE	4 (1)	96 (25)	27 (7)	8 (2)	79 (20)	23 (6)	237
1849	HOVEY LAKE	31 (8)	38 (10)	0 (0)	0 (0)	96 (25)	12 (3)	177
1850	VERSAILLES LAKE	8 (2)	31 (8)	4 (1)	27 (7)	88 (23)	15 (4)	173
1851	BASS LAKE	42 (11)	77 (20)	19 (5)	23 (6)	100 (26)	46 (12)	307
1852	CROOKED LAKE	81 (21)	100 (26)	77 (20)	81 (21)	35 (0)	75 (19)	449
1853	LAKE JAMES	88 (23)	92 (24)	100 (26)	96 (25)	35 (0)	75 (19)	486
1854	LONG LAKE	0 (0)	12 (3)	44 (11)	35 (9)	35 (0)	0 (0)	126
1855	PIGEON LAKE	37 (9)	8 (2)	44 (11)	46 (12)	35 (0)	27 (7)	197
1856	MARSH LAKE	15 (4)	73 (19)	35 (9)	15 (4)	35 (0)	4 (1)	177
1857	HAMILTON LAKE	58 (15)	65 (17)	73 (19)	31 (8)	35 (0)	19 (5)	281

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	1836	WAWASEE LAKE	546
2	1847	OLIVER LAKE	501
3	1853	LAKE JAMES	486
4	1844	TIPPECANOE LAKE	462
5	1843	LAKE MAXINKUCKEE	461
6	1846	OLIN LAKE	455
7	1852	CROOKED LAKE	449
8	1828	MONROE RESERVOIR	367
9	1837	WEBSTER LAKE	361
10	1845	DALLAS LAKE	324
11	1817	JAMES LAKE	323
12	1851	BASS LAKE	307
13	1841	WESTLER LAKE	306
14	1857	HAMILTON LAKE	281
15	1842	WITMER LAKE	279
16	1840	WINONA LAKE	260
17	1811	GEIST RESERVOIR	243
18	1848	SYLVAN LAKE	237
19	1805	CATARACT LAKE	217
20	1855	PIGEON LAKE	197
21	1856	MARSH LAKE	177
22	1849	HOVEY LAKE	177
23	1850	VERSAILLES LAKE	173
24	1839	WHITEWATER LAKE	157
25	1829	MORSE RESERVOIR	132
26	1854	LONG LAKE	126
27	1827	MISSISSINEWA RESERVOIR	105

APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107 x 10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR INDIANA 03/29/76

LAKE CODE 1846 OLIN LAKE

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 15.0

NORMALIZED FLOWS(CMS)

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1846A1	15.0	0.173	0.215	0.311	0.286	0.184	0.142	0.085	0.025	0.026	0.026	0.074	0.139	0.140
1846B1	12.7	0.144	0.181	0.263	0.244	0.156	0.119	0.071	0.021	0.022	0.022	0.062	0.119	0.118
1846ZZ	1.8	0.019	0.025	0.040	0.034	0.022	0.017	0.010	0.002	0.003	0.003	0.009	0.018	0.017

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 15.0 TOTAL FLOW IN = 1.62
SUM OF SUB-DRAINAGE AREAS = 14.5 TOTAL FLOW OUT = 1.69

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
1846A1	6	73	0.238	9	0.340				
	7	73	0.156	14	0.164				
	8	73	0.119	12	0.113				
	9	73	0.082	8	0.091				
	10	73	0.068	6	0.074				
	11	73	0.074	10	0.068				
	12	73	0.142	8	0.105				
	1	74	0.238	5	0.215				
	2	74	0.283	9	0.340	23	0.340		
	3	74	0.368	9	0.453	23	0.311		
	4	74	0.255	13	0.283				
	5	74	0.232	11	0.201				
1846B1	6	73	0.201	9	0.283				
	7	73	0.130	14	0.139				
	8	73	0.099	12	0.096				
	9	73	0.068	8	0.076				
	10	73	0.057	6	0.062				
	11	73	0.062	10	0.057				
	12	73	0.119	8	0.088				
	1	74	0.201	5	0.181				
	2	74	0.238	9	0.283	23	0.283		
	3	74	0.311	9	0.396	23	0.263		
	4	74	0.215	13	0.238				
	5	74	0.195	11	0.170				
1846ZZ	6	73	0.003	9	0.004				
	7	73	0.002	14	0.002				
	8	73	0.001	12	0.001				
	9	73	0.001	8	0.001				
	10	73	0.001	6	0.001				
	11	73	0.001	10	0.001				
	12	73	0.002	8	0.001				
	1	74	0.003	5	0.003				
	2	74	0.003	9	0.004	23	0.004		
	3	74	0.005	9	0.005	23	0.004		
	4	74	0.003	13	0.003				
	5	74	0.003	11	0.002				

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 76/03/30

134601
41 33 49.0 085 23 46.0 3
OLIN LAKE
18087 INDIANA

11EPALES 2111202
0062 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
73/05/04	13 40	0000	12.3		102	500	8.40	194	0.040	0.500	1.510	0.002K
	13 40	0006	12.1	10.8		480	8.40	184	0.030	0.400	1.430	0.002K
	13 40	0015	11.6	10.6		480	8.40	192	0.030	0.300	1.460	0.002K
	13 40	0022	9.8	9.7		480	8.10	184	0.040	0.300	1.420	0.002K
	13 40	0035	8.0	9.1		490	8.20	180	0.060	0.300	1.400	0.002K
	13 40	0048	7.9	9.2		500	8.40	190	0.070	0.400	1.420	0.002K
	13 40	0058	7.8	8.1		520	8.10	232	0.100	0.400	1.490	0.002K
73/08/06	10 05	0000	25.4		56	440	8.40	179	0.060	0.500	1.170	0.003
	10 05	0005	24.4	9.0		432	8.40	179	0.050	0.400	1.280	0.004
	10 05	0015	20.4	7.8		416	8.00	189	0.130	0.700	1.210	0.009
	10 05	0025	10.1	4.2		362	7.80	218	0.040	0.600	1.630	0.004
	10 05	0040	6.5	1.2		328	7.50	230	0.060	0.500	1.520	0.003
	10 05	0056	6.0	0.4		325	7.50	224	0.370	1.000	0.790	0.002
73/10/11	16 35	0000	19.9	9.6	132	377	8.50	157	0.050	0.500	0.910	0.012
	16 35	0010	18.9	9.4		370	8.40	156	0.040	0.500	0.900	0.011
	16 35	0015	15.3	8.8		367	8.40	156	0.040	0.600	0.920	0.012
	16 35	0020	9.9	4.8		390	7.90	181	0.050	0.500	1.410	0.013
	16 35	0030	8.5	0.4		342	7.40	201	0.050	0.600	1.450	0.013
	16 35	0040	6.6	0.2		328	7.40	201	0.140	0.600	0.950	0.013
	16 35	0058	6.1	0.1		327	7.30	226	0.810	1.600	0.050	0.026

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/03/30

184601
41 33 49.0 085 23 46.0 3
OLIN LAKE
18087 INDIANA

11EPALES 2111202
0062 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/05/04	13 40	0000	0.007	6.9
	13 40	0006	0.009	
	13 40	0015	0.011	
	13 40	0022	0.015	
	13 40	0035	0.011	
	13 40	0048	0.013	
	13 40	0058	0.011	
73/08/06	10 05	0000	0.009	3.5
	10 05	0005	0.009	
	10 05	0015	0.012	
	10 05	0025	0.011	
	10 05	0040	0.012	
	10 05	0056	0.015	
73/10/11	16 35	0000	0.013	4.2
	16 35	0010	0.012	
	16 35	0015	0.011	
	16 35	0020	0.013	
	16 35	0030	0.015	
	16 35	0040	0.015	
	16 35	0058	0.026	

APPENDIX E

TRIBUTARY DATA

STORET RETRIEVAL DATE 76/03/30

1846A1
41 33 55.0 085 23 48.0 4
OLIVER-OLIN LAKE CONNECTION
18 7.5 OLIVER LAKE
O/OLIN LAKE
BANK SAMPLE-APPROACH FROM LIMBERLOST CAM
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/06/09	13 30		1.400	0.700	0.011	0.005K	0.010
73/07/14	10 45		1.280	0.980	0.029	0.005K	0.005K
73/08/12	12 00		1.000	0.750	0.018	0.008	0.010
73/09/08	10 10		0.880	0.840	0.024	0.005K	0.005K
73/10/06	11 00		0.890	0.660	0.013	0.005K	0.010
73/11/10	10 20		1.010	0.600	0.036	0.005K	0.010
73/12/08	10 10		0.800	0.800	0.120	0.005K	0.015
74/01/05	10 15		0.910	0.500	0.080	0.016	0.016
74/02/09	11 00		1.010	1.300	0.045	0.005	0.030
74/02/23	10 45		0.940	0.600	0.020	0.005	0.015
74/03/09	10 50		1.360	1.300	0.035	0.010	0.045
74/03/23	10 45		1.510	1.500	0.030	0.005	0.015
74/04/13	10 15		1.090	1.850	0.035	0.005	0.015
74/05/11			1.040	0.700	0.035	0.005	0.020

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/03/30

184681
41 33 52.0 085 23 16.0 4
OLIN-MARTIN LAKE CONNECTION
18 7.5 OLIVER LAKE
I/OLIN LAKE
BANK SAMPLE-APPROACH RD END NW MARTIN LK
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/06/09	12	15	2.060	2.520	0.042	0.005K	0.020
73/07/14	10	55	1.740	1.300	0.070	0.005K	0.005K
73/08/12	12	00	0.820	0.670	0.022	0.008	0.010
73/09/08	10	20	0.420	0.840	0.018	0.005K	0.010
73/10/06	10	37	0.315	1.260	0.028	0.005K	0.010
73/11/10	10	45	0.924	0.600	0.016	0.005K	0.020
73/12/08	10	25	0.820	1.000	0.152	0.025	0.095
74/01/05	10	45	3.080	0.700	0.080	0.016	0.040
74/02/09	11	30	2.500	2.850	0.045	0.030	0.250
74/02/23	10	50	2.400	1.400	0.040	0.025	0.110
74/03/09	11	05	2.100	1.400	0.065	0.015	0.100
74/03/23	11	00	1.700	0.900	0.010	0.005	0.025
74/04/13	10	30	1.400	2.200	0.045	0.010	0.010
74/05/11			0.680	6.800	0.055	0.025	0.375

K VALUE KNOWN TO BE
LESS THAN INDICATED